CHEMISTRY

PAPER 1

(THEORY)

Maximum Marks: 70
Time Allotted: Three Hours
Reading Time: Additional Fifteen minutes

Instructions to Candidates

- You are allowed **additional 15 minutes** for **only** reading the question paper.
- You must **NOT** start writing during the reading time.
- This question paper has **11** printed pages.
- It is divided into **four sections** and has **21 questions** in all.
- All questions are compulsory. Answer **all** questions.
- **Section A** has **fourteen subparts**. Each question carries 1 mark.
- While attempting **Multiple Choice Questions** in Section A, you are required to **write only ONE option as the answer**.
- **Section B** has **ten questions**. Each question carries 2 marks.
- **Section C** has **seven questions**. Each question carries 3 marks.
- **Section D** has **three questions**. Each question carries 5 marks.
- ***Internal choices*** have been provided in ***one question each in Sections B, C and D.***
- The intended marks for questions are given in brackets [ ].
- All working, including rough work, should be done on the same sheet as, and adjacent to the rest of the answer.
- Balanced equations must be given wherever possible and diagrams where they are helpful.
- When solving numerical problems, all essential workings must be shown.
- In working out problems, use the following data:

Gas constant $R = 1{\cdot}987 cal\ deg^{-1} mol^{-1} = 8{\cdot}314 JK^{-1} mol^{-1}$
$= 0{\cdot}0821 dm^3 atm K^{-1} mol^{-1}$, *1 l atm* $= 1 dm^3 atm = 101{\cdot}3$ *J.*
1 Faraday = 96500 coulombs. Avogadro's number $= 6{\cdot}023 \times 10^{23}$.

Instruction to Supervising Examiner

- Kindly read **aloud** the Instructions given above to all the candidates present in the examination hall.

SECTION A - 14 MARKS

Question 1

(A) Fill in the blanks by choosing the appropriate word(s) from those given in the brackets: **[4×1]**

[four, three, remains same, propane, ns^{1-2}, increases, six, propan-2-ol, $(n-1)d^{1-10}$, two, decreases, Clemmensen's, Wolff-Kishner]

(i) The molar conductance of a solution _____ on dilution but the specific conductance of a solution _____ on dilution. **(Understanding)**

(ii) In the complex ion $[CoCl(en)_2ONO]^+$, the coordination number and the oxidation number of the central metal ion are _____ and _____. **(Understanding)**

(iii) Propanone on reaction with zinc amalgam in the presence of concentrated HCl gives _____ and the reaction is called _____ reduction. **(Recall)**

(iv) The variation and magnitude of oxidation state in coordination complexes is due to the participation of inner _____ electrons in addition to outer _____ electrons. **(Understanding)**

(B) Select and write the correct alternative from the choices given below. **[7×1]**

(i) The correct order of the increasing basic nature of Ammonia, Methylamine and Aniline is: **(Analysis)**

(a) Methylamine < Aniline < Ammonia

(b) Aniline < Methylamine < Ammonia

(c) Ammonia < Aniline < Methylamine

(d) Aniline < Ammonia < Methylamine

(ii) Colligative properties of a solution are: **(Understanding)**

(P) Independent of the nature of solute

(Q) Proportional to molecular mass of solute

(R) Proportional to concentration of solute

(S) Independent of the amount of solvent

(a) Only P and Q are correct

(b) Only P and R are correct

(c) Only P and S are correct

(d) Only Q and S are correct

(iii) According to Markownikoff's rule, "The negative part of the halogen acid attaches itself with that C atom of an unsymmetrical alkene which has least number of H-atom."

Anti-Markownikoff's addition of HBr is **NOT** observed in: **(Analysis)**

(a) Propene

(b) But-2-ene

(c) But-1-ene

(d) Pent-2-ene

(iv) Most of the naturally occurring α-amino acids are optically active and have L-configuration. Which of the following amino acids is **NOT** asymmetric? **(Recall)**

(a) Valine

(b) Alanine

(c) Glycine

(d) Leucine

(v) Which one of the following complex ions has geometrical isomers? **(Understanding)**

(a) $[Ni(NH_3)_5Br]^+$

(b) $[Cr(NH_3)_4en]^{3+}$

(c) $[Co(NH_3)_2(en)_2]^{3+}$

(d) $[Co(NH_3)_6]^{3+}$

(vi) Given below are two statements marked Assertion and Reason. Read the two statements carefully and select the correct option.

Assertion: Tertiary butyl bromide undergoes Wurtz reaction to give 2,2,3,3 tetramethyl butane.

Reason: In Wurtz reaction, when same alkyl halides react with sodium in dry ether to give hydrocarbon; the hydrocarbon formed contains double the number of carbon atoms present in the alkyl halide. **(Analysis)**

(a) Both Assertion and Reason are true and Reason is the correct explanation of assertion.

(b) Both Assertion and Reason are true but Reason is not the correct explanation for Assertion.

(c) Assertion is true but Reason is false.

(d) Both Assertion and Reason are false.

(vii) Given below are two statements marked Assertion and Reason. Read the two statements carefully and select the correct option.

Assertion: There is a continuous increase in size among Lanthanoids with an increase in atomic number.

Reason: Lanthanoids do not show Lanthanoid contraction. **(Analysis)**

(a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

(b) Both Assertion and Reason are true but Reason is not the correct explanation for assertion.

(c) Assertion is true but Reason is false.

(d) Both Assertion and Reason are false.

(C) **Read the passage carefully and answer the questions that follow.** **[3×1]**

A plant or any other living being maintains a reasonable balance of C-14 (radioactive carbon) in its tissue during its lifetime. C-14 is used to determine the age of fossils. In the upper atmosphere, neutrons present in the cosmic rays are captured to produce the following nuclear reaction.

$$_{7}N^{14} + {}_{0}n^{1} \longrightarrow {}_{6}C^{14} + {}_{1}H^{1}$$

C-14 isotope is circulated in the atmosphere and gets absorbed by living organism during photosynthesis. The ratio of C-14 to C-12 in living being is $1:10^{12}$. Once the living being dies, the level of C-14 in the dead being decreases due to the following reaction.

$$_{6}C^{14} \longrightarrow {}_{7}N^{14} + {}_{-1}e^{0} + \gamma \text{ rays}$$

The death of the plant brings an end to its tendency to take up C-14. The half-life period of C-14 is 5770 years. By knowing the concentration of C-14 in the living plant and the piece of dead material at a particular time, the age of the material (fossil) can be determined.

(i) Write the relation between the decay constant and half-life period. **(Recall)**

(ii) In a piece of dead wood, the activity or concentration of C-14 is found to be one third of its initial activity. Calculate the age of the old wood. **(Application)**

(iii) The half-life period ($t_{1/2}$) for a first order reaction is 30 minutes. Calculate the time taken to complete 87·5% of the reaction. **(Application)**

SECTION B – 20 MARKS

Question 2 **[2]**

The solution of two electrolytes A and B are diluted. $\wedge_m$ of B increases 1·5 times while that of A increases 25 times. Which of the two is a strong electrolyte? Give a reason.

(Understanding)

Question 3 **[2]**

An organic compound [A] which has characteristic odour, reacts with conc. NaOH to give two compounds [B] and [C]. Compound [B] has molecular formula C_7H_8O which upon oxidation gives back compound [A]. Compound [C] is the sodium salt of the acid and upon treatment with sodalime yields an aromatic hydrocarbon [D]. Identify the compounds [A], [B], [C] and [D]. **(Understanding)**

Question 4 **[2]**

Devise a scheme for the synthesis of n-butane using CH_3I as the only source of carbon. Is it possible to obtain propane in pure state by applying this scheme? Give a reason for your answer. **(Evaluate)**

Question 5 **[2]**

It is generally observed that the rate of a chemical reaction becomes double with every 10^oC rise in temperature. If the generalisation holds true for a reaction in the temperature range of 298K to 308K, what would be the value of activation energy (E_a) for the reaction? **(Application)**

Question 6 **[2]**

An organic compound [X] of molecular formula C_3H_5N, in one reaction produced a primary amine with $LiAlH_4$. In another case, the organic compound [Y] of same molecular formula C_3H_5N produced a secondary amine with $LiAlH_4$. Identify both the compounds [X] and [Y]. Why do these compounds form two different products?

(Understanding)

Question 7 **[2]**

During chemistry class, a teacher wrote $[Ni(CN)_4]^{2-}$ as a coordination complex ion on the board. The students were asked to find out the magnetic behaviour and shape of the complex. Pari, a student, wrote the answer paramagnetic and tetrahedral whereas another student Suhail wrote diamagnetic and square planer.

Evaluate Pari's and Suhail's responses. **(Evaluate)**

Question 8 **[2]**

An organic compound 'X' with molecular formula $C_4H_{10}O$ is found to be soluble in conc.H_2SO_4 and does not react with sodium metal or $KMnO_4$. Compound 'X' when heated with excess of HI gives a single alkyl halide. Deduce the structure of the compound 'X'. Explain all the reactions involved. **(Understanding)**

Question 9 **[2]**

(i) Identify the compounds [A] and [B] in the following reactions. **(Understanding)**

(a) $C_6H_5CHO \xrightarrow[(2)\ SOCl_2]{(1)\ K_2Cr_2O_7/H_2SO_4} [A] \xrightarrow{C_6H_6(\text{anhy. } AlCl_3)} [B]$

(b) $CH_3\text{-}C{\equiv}CH \xrightarrow[(2)\ \text{vigorous oxidation, conc.}HNO_3]{(1)\ H_2SO_4/HgSO_4} [A] \xrightarrow[[\text{conc. } H_2SO_4]]{C_2H_5OH} [B]$

OR

(ii) Three organic compounds A, B and C are non cyclic functional isomers of carbonyl compounds with molecular formula C_4H_8O. Isomers A and C give positive Tollen's test while compound B does not give positive Tollen's test but gives positive iodoform test. Compounds A and B on reduction with Zn amalgam and conc. HCl give the same product.

(a) Write the structures of the compounds A, B and C. **(Understanding)**

(b) Out of the compounds A, B and C, which one will be the least reactive towards addition of HCN. **(Understanding)**

Question 10 **[2]**

Calculate the value of E^ocell, E cell and ΔG that can be obtained from the following cell at 298K.

$Al/Al^{3+}_{(0.01M)}$ // $Sn^{2+}_{(0.015M)}/Sn$

Given $E^oAl^{3+}/Al = -1{\cdot}66V$; $E^oSn^{2+}/Sn = -0{\cdot}14$**V** **(Application)**

Question 11 **[2]**

Write the chemical test to distinguish between the following pairs of compounds. **(Understanding)**

(i) Propan-1-ol and Propan-2-ol

(ii) Phenol and ethanol

SECTION C – 21 MARKS

Question 12 **[3]**

Identify the compounds [A], [B] and [C] in the following reactions.

(i) $C_6H_5NO_2 \xrightarrow[Sn/HCl]{6[H]} [A] \xrightarrow[273K\text{-}278K]{HNO_2 + HCl} [B] \xrightarrow{C_6H_5NH_2} [C]$

(Understanding)

(ii) $CH_3CH_2NH_2 \xrightarrow[(2)\ P/Cl_2]{(1)\ HNO_2} [A] \xrightarrow[(2)\ H_2O/H^+]{(1)\ KCN} [B] \xrightarrow[(2)\ Br_2/KOH]{(1)\ NH_3/heat} [C]$

(Understanding)

Question 13 **[3]**

The molar mass calculated through colligative properties is sometimes different from that of experimentally determined molecular mass and is known as *abnormal molecular mass*. This difference is due to the solute particles that undergo association or dissociation.

Consider the two cases given below and answer the questions that follow.

(A) The freezing point of a solution containing 5·85g of NaCl in 100g of water is − 3·348°C. ($K_f$of water = 1·86 K kg mol^{-1}, molecular mass of NaCl = 58·5)

(B) The freezing point of benzene solution decreases by 0·45°C when 0·2g of acetic acid is added to 20g of benzene.
($K_f$of benzene = 5·12 K kg mol^{-1}, molecular mass of acetic acid = 60)
Answer the following questions.

(i) Calculate the abnormal molecular mass of solute in both the cases. **(Application)**

(ii) Inferring the value of van't Hoff factor in both the cases, find out which solution undergoes association and which solution undergoes dissociation. **(Analysis)**

(iii) Given below is the increasing order of depression in freezing point of water observed for equimolar concentrations of the compounds,

acetic acid < trichloro acetic acid < trifluoro acetic acid

Provide a reason to explain if the above ordered arrangement is correct or not. **(Understanding)**

Question 14 **[3]**

Write chemical equations to illustrate the following name reactions. **(Recall)**

(i) Rosenmund's reaction

(ii) Benzoin condensation

(iii) Perkin's reaction

Question 15 **[3]**

(i) Assuming that cyanide is a strong ligand, write the formula of two coordination complex ions with cyanide and iron having coordination number six. Name the complex ions. **(Application)**

(ii) On the basis of Crystal Field Theory, write the electronic configuration of d^4 ion if: **(Application)**

(a) $\Delta_o > P$

(b) $\Delta_o < P$

Question 16 **[3]**

(i) Dry cells are commonly used in clocks, torches, calculators etc. They are the most familiar type of commercial cells.

(a) What acts as anode and cathode in dry cell? **(Understanding)**

(b) Which chemical compounds are filled between anode and cathode of this cell? **(Understanding)**

(c) Why do dry cells not have a long life? **(Understanding)**

OR

(ii) Answer the following:

(a) What happens to the voltage when the salt bridge is removed from the two half cells and why? **(Understanding)**

(b) Copper sulphate solution cannot be stored in a zinc pot. Why? **(Understanding)**

(c) Why does the density of H_2SO_4 in a lead storage battery decrease as it is discharged? **(Understanding)**

Question 17 **[3]**

(i) The structures of glycine and alanine are given below. Show the peptide bond linkage in glycylalanine. **(Understanding)**

Glycine Alanine

(ii) What products would be formed when a nucleotide from DNA containing thymine is hydrolysed? **(Understanding)**

(iii) What are *reducing sugars*? Give an example. **(Recall)**

Question 18 **[3]**

Consider the data given below for the reaction A + B ⟶ Product

S.No.	conc. of [A] mol L^{-1}	conc. of [B] mol L^{-1}	Rate; mol $L^{-1}sec^{-1}$
1.	0·1	0·1	$4{\cdot}0 \times 10^{-4}$
2.	0·2	0·2	$1{\cdot}6 \times 10^{-3}$
3.	0·5	0·1	$1{\cdot}0 \times 10^{-2}$
4.	0·5	0·5	$1{\cdot}0 \times 10^{-2}$

Answer the following questions.

(i) What is the order of reaction with respect to A and B? **(Application)**

(ii) Calculate the rate constant. **(Application)**

(iii) Determine the reaction rate when the concentration of A and B are 0·2 mol $L^{-1}sec^{-1}$ and 0·35 mol $L^{-1}sec^{-1}$ respectively. **(Evaluate)**

SECTION D – 15 MARKS

Question 19 **[5]**

Phenol, one of the deadliest acids, contains a hydroxy group directly attached to the aromatic ring. A hydroxy group attached to an aromatic ring is also referred to as a phenolic group. Due to the presence of -OH group, phenols show many reactions similar to those of alcohols. The direct attachment of -OH group to the aromatic ring makes its behaviour very different from that of alcohols. That is why phenol behaves differently from alcohols in many reactions. The chemical reactions of phenol can be categorised as follows:

- Reactions involving -OH group
- Reactions involving benzene ring

(i) Write the chemical equation for the preparation of phenol from benzene using H_2SO_4 and NaOH. **(Understanding)**

(ii) What happens when phenol reacts with Br_2/CS_2 at low temperature? **(Recall)**

(iii) What is observed when phenol is treated with neutral ferric chloride solution? **(Recall)**

(iv) Write the reaction when phenol is treated with conc. HNO_3 in the presence of conc. H_2SO_4. **(Understanding)**

(v) Write the reaction when phenol is treated with chloroform in the presence of aqueous NaOH at 340K. **(Understanding)**

Question 20 **[5]**

(i) Give a reason for each of the following.

(a) The purple colour of $KMnO_4$ disappears in the presence of acidified solution of oxalic acid. **(Understanding)**

(b) Some transition metals and their compounds get attracted towards the magnetic field. **(Understanding)**

(c) Why are Mn^{2+} compounds more stable than Fe^{2+} towards oxidation to the +3 state? (atomic no. of Mn = 25 and Fe = 26) **(Understanding)**

(ii) Complete and balance the following reactions. **(Recall)**

(a) $KMnO_4 + H_2SO_4 + FeSO_4 \rightarrow$ _____+ _____+_____+_____

(b) $K_2Cr_2O_7 + H_2SO_4 + KI \rightarrow$ _____+ _____+_____+_____

Question 21 **[5]**

(i) Osmosis and osmotic pressure play a very significant role in biological processes. The osmotic pressure of human blood is 8·21 atm at 27°C. It is interesting to know that a 0·91% (mass/volume) solution of NaCl, known as *saline water* is isotonic with fluids inside the human red blood cells. In this solution, the blood corpuscles neither swell nor shrink. Therefore, medicines are mixed with saline water before being injected into the veins.

Answer the following questions.

(a) What is an *isotonic solution*? **(Recall)**

(b) How much glucose should be used per 100ml (aqueous solution) for intravenous injection that is isotonic with blood at 27°C? **(Application)**

(c) What would be the osmotic pressure of blood if the temperature is 37°C? **(Application)**

(d) A pure NaCl solution with salt concentration less than 0·91% (mass/volume) is hypertonic solution to human blood. Is this statement true or false? Give a reason. **(Understanding)**

(e) Name the disease caused by taking a lot of salt or salty food, which results in water retention in tissue cells causing puffiness or swelling. **(Recall)**

OR

(ii) (a) Calculate the boiling point of urea solution when 8·0g of urea is dissolved in 250g of water. Boiling point of pure water is 373K.

(k_b of water = 0·52 K kg mol^{-1}, molecular mass of urea = 60 g mol^{-1}) **(Application)**

(b) Ethylene glycol is used as an antifreeze agent. Calculate the amount of ethylene glycol to be added to four kilogram of water to prevent it from freezing at -6°C.

(K_f of water = 1·86 K kg mol^{-1}) Assume that ethylene glycol ($CH_2OH.CH_2OH$) does not dissociate or associate in aqueous solution.

(Application)

(c) What will be the effect on the value of molality and molarity of a solution with change in temperature? **(Understanding)**